Enterprise Information Technology Architecture Framework:

Business Drivers and Architecture Principles

US Department of Education
Student Financial Assistance Programs (SFA)

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Executive Summary

The Student Financial Assistance Programs (SFA) of the Department of Education are embarking on an effort to improve service to SFA customers and stakeholders while efficiently managing program costs. Improving the information technology supporting SFA and business process reengineering are key to this effort. The development of a standards-based enterprise architecture to guide this effort is crucial. The enterprise architecture is the framework of principles, recommended practices, guidelines, policies, standards, and products, which direct the design, analysis, construction, deployment, and management of information technology and systems across the enterprise. This document is the first of several planned deliverables which will document SFA's enterprise architecture. SFA is following DOD's Technical Architecture Framework for Information Management (TAFIM) which both defines the process of developing an enterprise architecture and defines the deliverables.

The enterprise architecture will also facilitate SFA's compliance with the Clinger-Cohen act. Clinger-Cohen states information technology implementation should be done in the context of an architecture. Additionally, information technology investments are to be managed as a portfolio – each investment is required to be checked for compliance with the enterprise architecture as part of the investment management process.

The Department of Education (ED) is the smallest federal department, with less than 5,000 staff. The number of programs administered in FY 1997 was 197. ED provided or oversaw $67.6 billion in aid to education in FY 1997, including program funding, new student loans, and federal administration.

SFA is responsible for a portfolio of outstanding student loans that totaled about $131 billion in FY 1997. Federal funds provide or guarantee a very large share of student financial aid. In 1994–95, federal education funds represented 74.7% of all student financial aid awarded to postsecondary students.

The mission of SFA is to administer and manage postsecondary student loans and aid in an efficient and effective manner. This mission was supported by 1993 legislation: The *Student Loan Reform Act* helped make the college student aid system more efficient by authorizing a new Direct Student Loan Program that is giving postsecondary institutions and students expanded choice among alternative aid providers and offering streamlined aid. SFA has provided one-stop shopping for information on student loans and grants.

The effective use of information technology and automation of SFA's processes is key to supporting continued growth in student financial aid funding and management.

Business Drivers

The following business goals have been identified from the business environment and strategic challenges facing SFA, the external and internal forces affecting the future of SFA, internal SFA planning documents, and EASI project documentation.

Department of Education's challenges for the next decade:

- Create a student, prospective student, and family-focused "system" to support postsecondary education.
- Provide the customer a single point of interface for federal programs and potentially with the larger postsecondary education community.
- Streamline, simplify and improve the accessibility of processes and data associated with postsecondary education.
- Reduce costs and improve program integrity and oversight associated with the management and delivery of postsecondary education services.
- Support lifelong learning at multiple schools.

Conceptual Architecture

The Conceptual Architecture is the framework of principles, recommended practices, guidelines, policies, and standards which direct the design, construction, deployment, and management of information technology and systems across SFA. The objective of the conceptual architecture is to guide SFA in the implementation of a technical infrastructure that is aligned with business goals and supports future change in the business and its administrative processes.

The conceptual architecture principles are:

1. **The Architecture Must Support the Business**: The enterprise architecture and standards will be designed to (1) support and optimize SFA operations, (2) be highly flexible to accommodate future business changes and (3) help ensure the overall success of the SFA business.
2. **Periodic Architecture Review, Alignment, & Refreshment**: The IT architecture will be periodically reviewed (at least annually) and updated according to a disciplined, structured maintenance and technology refreshment process. This structure will include a configuration management process and supporting tools.
3. **Reengineer Business Processes and Supporting IT Together**: New information systems will be implemented after work processes have been analyzed, simplified or otherwise redesigned as appropriate, in compliance with the Clinger-Cohen legislation and Raines' rules.
4. **Architecture Enforcement:** The information systems and technology infrastructure implemented by SFA will be compliant with the SFA Enterprise Architecture and Common Operating Environment (COE) described within.
5. **Use Industry Proven Technology**: Information technology applications and technical infrastructure decisions must be based on industry proven and supported components, methods, standards, and tools consistent with industry technological and market direction.
6. **No vendor bias:** Standards and technology choices will be based on vendor-neutral standards where they are available and realistically can be implemented. Products will be chosen from

any vendor with strong business stability, who provides the best technology and service for a business need and whose products are compliant with its architecture standards.

7. **Solutions Preference:** Where most cost effective and beneficial, SFA's solutions preference will be (1) outsourcing; (2) commercial-off-the-shelf (COTS) products; (3) reuse of existing applications; and (4) custom applications.
8. **Access to Information**: Timely access to information and the tools and applications required to access and manipulate that information will be available to all individuals unless there is a specific, compelling reason to restrict access.
9. **Reduce Integration Complexity:** Products, tools, designs, applications, and methods will be selected to reduce integration and infrastructure complexity.

These component architecture principles are described in more detail within this document.

The Enterprise Information Technology Architecture Project Description

Purpose and Scope of Project - Why Architecture? And What Is It?

In today's competitive environment, effective and efficient use of information technology is the focus in building successful business strategies. Enterprise information technology architectures create the framework for this leveraged use of technology. Creating an enterprise architecture serves four basic functions; (1) - it creates a set of principles that guide future decision making, application design, outsourcing alternatives, and product evaluation; (2) - it is the process for building consensus among business units and the Information Technology (IT) organization and establishes an ongoing working relationship for the continuous alignment of information technology throughout the organization; (3) - it implements Clinger-Cohen act requirements for federal agencies to implement information systems in the context of an architecture; and (4) – creates opportunities for efficiency gains and cost reduction / cost avoidance.

The enterprise architecture is the framework of principles, recommended practices, guidelines, policies, standards, and products, which direct the design, analysis, construction, deployment, and management of information technology and systems across the enterprise. The objective of the architecture is to guide the IT organization in the implementation of a technical infrastructure which supports change in the business and administrative processes of the enterprise. Open and adaptive technical architectures guide the development of a technology base and structure, which enable sustainable competitive advantage for the enterprise through periods of rapid change. The principles and best practices of open and adaptive enterprise information technology architecture are consistent across industries and may be achieved utilizing a wide range of vendor product offerings.

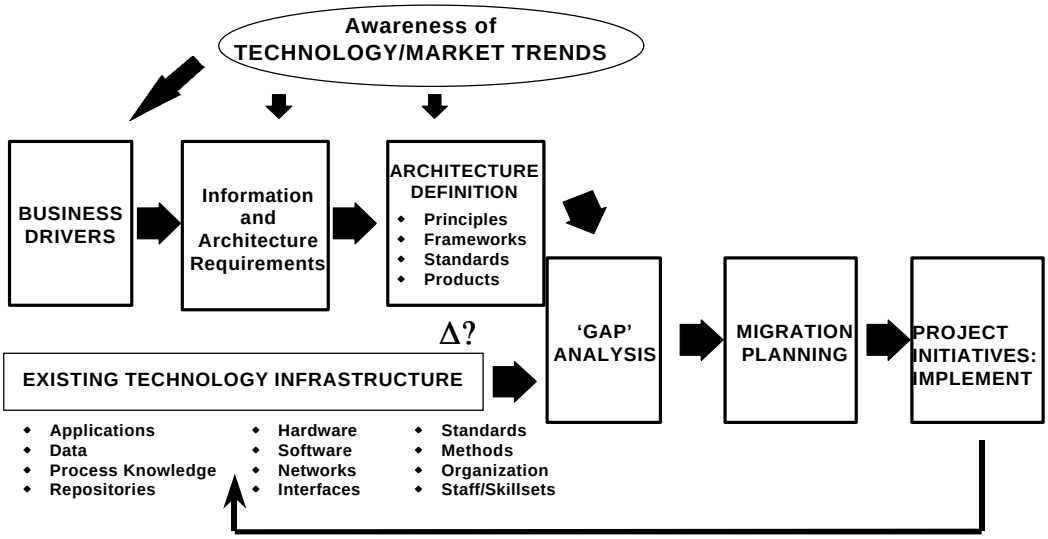
The scope of the information technology architecture is to provide a single, common and cohesive vision - to senior management, line organizations, IT staff and end users of the underpinnings, design points, principles and recommended practices of open and adaptive infrastructures and information systems.

This view of information technology architecture is consistent with that of the General Accounting Office, which defines an information technology architecture as "an integrated framework for evolving or maintaining existing information technology and acquiring new information technology to achieve the agency's strategic and information resources management goals."[1] This definition is further defined as: "A complete IT architecture should consist of both logical and technical components. The logical architecture provides the high-level description of the agency's mission, functional requirements, information requirements, system components, and information flows among the components. The technical architecture defines the specific IT standards and rules that will be used to implement the logical architecture."

[1]United Stated General Accounting Office, Assessing Risks and Returns: A Guide for Evaluating Agencies' Information IT Investment Decision Making, 1997

Methodology

The approach for developing the SFA enterprise architecture is based on the Technical Architecture Framework for Information Management (TAFIM), a top down, business driven approach: (See Appendix D for a description of these elements.)



This model begins with a clear focus on key business drivers and results in a cohesive architecture and practical infrastructure that can be implemented using today's technology. It is an iterative cycle emphasizing periodic assessment of business needs as the key to building solid IT foundations.

The Plan

The process of defining such an information environment begins with an understanding of the current business, competitive factors, regulatory issues, business plans, strategic directions, current operational issues, customer issues, organizational strengths and weaknesses, and resource and budget issues. This information is the knowledge base for the business drivers and goals. The architecture requirements were derived from both the SFA business requirements and industry best practices and technology.

These requirements drive a set of conceptual and component architecture principles that form the base foundation of the architecture.

Business Drivers and Goals

This section presents the principal SFA business requirements and initiatives that will drive the SFA Information Technology Architecture definition. Creating, defining, and recognizing these business drivers: requirements, opportunities, imperatives, and challenges, is an initial key step in defining an information technology architecture that is aligned with the business and supports the future strategic directions and growth opportunities of SFA.

The Department of Education – SFA Business Environment

The Department of Education (ED) is the smallest federal department, with less than 5,000 staff. The number of programs administered in FY 1997 was 197. ED provided or oversaw $67.6 billion in aid to education in FY 1997, including program funding, new student loans, and federal administration. It breaks down as follows:

- Congressional appropriations for program activities: $32.0 billion. These funds are used for grants to state and local agencies, higher education institutions, other entities, contracts, and subsidies for direct and guaranteed student loans.
- New student loans: $34.7 billion. Postsecondary education student loans are made by ED or guaranteed by ED and issued by banks and other financial institutions.
- Federal administration: $807.7 million. Department of Education salaries and expenses totaled 1.2% of the FY 1997 dollars for aid to education.

Student Financial Assistance Programs (SFA) is responsible for a portfolio of outstanding student loans that totaled about $131 billion in FY 1997. Federal funds provide or guarantee a very large share of student financial aid. In 1994–95, federal education funds represented 74.7% of all student financial aid awarded to postsecondary students. Given that SFA is part of a small department with a large portfolio of loans and grants to manage, a standards-based architecture approach is critical to optimizing SFA's information technology investments.

Mission

The Department of Education's mission is to ensure equal access to education and to promote educational excellence throughout the nation. We promote educational excellence for all students by providing financial support to states and local agencies in areas of national priority, promoting challenging standards, getting families and communities involved in schools, providing information on the best educational practices, ensuring that postsecondary education is affordable, and providing high-quality statistics and evaluations on federal programs.

Specifically, the mission of SFA is to administrate and manage postsecondary student loans in an efficient and effective manner. This mission was supported by 1993 legislation: The *Student Loan*

Reform Act helped make the college student aid system more efficient by authorizing a new Direct Student Loan Program that is giving postsecondary institutions and students expanded choice among alternative aid providers and offering streamlined aid.

SFA Business Drivers

Business drivers are external forces which SFA has very little direct control but which will require SFA to change. Generically they include competition, regulation/deregulation, customers, stakeholders, partners, the job market, the economy, laws and regulations, and technology trends/developments. SFA must be prepared to deal with such forces and adapt information technology architecture, as appropriate. The following are the business drivers for SFA.

- *New laws and regulations which result in new business requirements for SFA.* New laws impacting SFA can be passed and signed into law at any time. Additionally, Student Financial Aid is reauthorized every 5 years and new requirements for SFA result. Reauthorization is due for 1998. New student financial aid programs can also be created at any time.
- *Normal ups and downs of the U.S. business cycle*, which could impact interest rates, demand for loans and the ability of students to repay existing loans. Currently the economy is strong and interest rates are at 30-year lows.
- *Demographics and population trends*. Significant student loan and grant growth is expected over the next few years.
- *Presidential policy directives* create requirements for SFA and in some cases direct how SFA should address business issues. For example, the administration believes SFA should utilize the existing commercial infrastructure as extensively as possible for appropriate functions.
- *Competition and customer expectations for high levels of customer service commensurate with the service level customers receive from "world class" private sector organizations*. For example, customers expect ready access to complete information about their business dealings with SFA.
- *Budget resources*. SFA budgets will likely remain constrained, although new resources could be made available for critical initiatives.
- *Internal desire and external pressure to operate as efficiently as possible*. As noted in a number of reports by the General Accounting Office and the Inspector General, many management and operations problems still remain. (Perhaps the most important of these are: (1) the various student aid systems are not totally integrated, (2) financial data from aid programs are only partially consolidated at the student level, and (3) too many contractors use different operating systems. Correcting this situation will require the redesign and modernization of the federal financial aid system. The EASI project is already addressing many of these issues. SFA is also committed to strengthening its oversight of the student aid programs while reducing the burden for high-performing institutions.)

- *The trend toward integrated delivery of government services.* This will likely broaden and impact SFA. For example, financial, accounting, contracting, and other major business systems will move toward greater integration and enhancement.
- *The pace of technology development will continue to accelerate*. SFA will continue to require technological changes and adaptations to take advantage of new standards and increased capabilities.
- *Year 2000 compliance requirements.* The Department is currently undertaking a major effort to become Year 2000 data compliant.

Dept. of Ed. Business Goals

The Department's September 1997 strategic plan sets out four major goals for the U.S. Department of Education:

1. Help all students reach challenging academic standards so that they are prepared for responsible citizenship, further learning, and productive employment.
2. Build a solid foundation for learning for all children.
3. Ensure access to postsecondary education and lifelong learning.
4. Make ED a high-performance organization by focusing on results, service quality, and customer satisfaction.

These goals have set the following challenges / goals for SFA over the next decade in response to SFA's business drivers:

- Create a student, prospective student, and family-focused "system" to support postsecondary education.
- Provide the customer a single point of interface for federal programs and potentially with the larger postsecondary education community.
- Streamline, simplify and improve the accessibility of processes and data associated with postsecondary education. Make information more accessible in a secure manner.
- Reduce costs and improve program integrity and oversight associated with the management and delivery of postsecondary education services.
- Support lifelong learning at multiple schools.

To meet the challenges, SFA must leverage information technology and develop a world-class comprehensive student financial aid delivery system that:

- is easy to use for everyone, including students and their families, financial aid officers, and U.S. Department of Education officials.
- makes SFA fully competitive in the open market place of ideas, services, and products.

- reduces administrative costs and paperwork burden for everyone while dramatically reducing fraud and abuse.
- fully integrates all federal student financial aid programs, including grants, work-study, and loans.
- is flexible to accommodate changes in programs, regulations and customer service options.

Metrics

Through the leveraged use of information technology, postsecondary student aid delivery and program management will be more efficient, financially sound, and customer-responsive. SFA plans to measure this through these performance indicators:

1. Customer satisfaction ratings among students, parents, and postsecondary institutions participating in the student aid programs will increase to 90% by 2001.
2. The accuracy and integrity of data supplied by applicants, institutions, lenders, and guaranty agencies will show continuous yearly improvements.
3. Evaluation of contracts for major SFA financial aid systems will indicate that the government and the taxpayer are receiving "better than fully successful" performance (including quality, cost control, and timeliness).
4. There will be no material internal weaknesses identified in the student aid programs' portions of the Department-wide financial statement audit; and there will be no student aid program issues that prevent the Department from receiving an unqualified opinion on the financial statements.
5. The percentage of postsecondary institutions found to be in substantial compliance with federal requirements would increase each year.
6. The annual recovery rate on defaulted student loans will show continuous improvement.
7. The cohort default rates—the percentage of borrowers leaving school who default within two years—for the Federal Family Education Loan and the Direct Loan Program will decline to a level of 10% or less by 2002.
8. During 1998, the length of time to fully complete a loan consolidation application will average no more than 60-90 days; future surveys of borrowers will show that an increasing percentage of applicants for loan consolidation are highly satisfied with the timeliness and accuracy of the loan consolidation process.
9. By September 1998, ED will have a complete system architecture developed for the delivery of federal student financial aid; implementing this design will improve customer service and increase control over federal costs.

Future State Vision

Much of the future technology environment for SFA is based on the EASI project, currently in the Definition Phase. This project will streamline the delivery and management of student aid. The following are visions of the SFA "future world" as seen by a prospective student.

The vision from the student's perspective:

Involvement with Project EASI might begin as soon as a child is born, when parents initially begin planning for the child's education. Through information sharing, Project EASI is envisioned to support planning long before a potential student is ready to attend a postsecondary institution. Project EASI would provide a single point of entry to coordinated, timely, and comprehensive sources of information regarding a wide range of relevant topics (e.g., financial planning, employment outlook for graduates, financial assistance, institution curriculum and quality). Each information provider would retain ownership of its data, with Project EASI acting as the network and pointer to the various sources. General information obtainable through Project EASI would be available to anyone. In addition, Project EASI would specifically support improved information sharing with students and financial aid recipients throughout the financial aid life cycle.

As the time for an individual to attend a postsecondary institution draws near, Project EASI is envisioned supporting application for enrollment in an institution, as well as application for financial aid. While a prospective student would not be required to apply for enrollment through Project EASI, a prospective financial aid recipient would be required to use Project EASI to apply for aid. The Project EASI vision encompasses support to financial aid entrance counseling, applying for financial aid, aid packaging and origination (for all Title IV student aid programs and for most state financial aid sources), and automatic renewal of financial aid eligibility based upon data obtained by Project EASI from other automated sources and updated by the applicant.

After aid is approved and the student is enrolled in school, Project EASI would support disbursement of funds to schools, Under Project EASI, there would be a single, streamlined payment process for postsecondary financial aid programs. This process is envisioned in a way that would eliminate the need for after-the-fact reconciliation between schools and fund sources. In addition, the single payment process is expected to support better use and control of funds.

Beginning while an aid recipient is in school and continuing through the repayment cycle, Project EASI would be the central repository for enrollment status data for all students and would ensure that this data receives timely dissemination to most appropriate fund sources. An effective enrollment status tracking and reporting process would eliminate the need for paper-based deferment request, and is expected to minimize the incidence of defaults caused by failure to request deferments from all funds sources and to help ensure that loans enter repayment at the correct time.

Once a student leaves school, Project EASI would facilitate the repayment process, beginning with notification to borrowers of repayment responsibilities and options. Project EASI is also

envisioned supporting what-if analysis of repayment options, supporting the loan consolidation process, replacing manual forbearance processing, processing payments from borrowers, and supporting collection activities. If an aid recipient subsequently returned to school, or had a child of his or her own, the postsecondary education life-cycle would repeat.

Architecture Principles

The Conceptual Architecture is the framework of principles, recommended practices, guidelines, policies, and standards which direct the design, construction, deployment, and management of information technology and systems across SFA. The objective of the conceptual architecture is to guide SFA in the implementation of a technical infrastructure, which is aligned with business goals and supports future change in the business and its administrative processes.

The scope of the Conceptual Architecture Framework is to provide a single, common and cohesive vision - to senior management, line organizations, IT staff, and end users of the underpinnings, design points, principles and recommended practices of open and adaptive enterprise–wide technical architectures. The principles described in the following sections include overall framework principles as well as more specific component principles regarding data architecture, application architecture, technical infrastructure architecture, and IT management.

Architecture Framework

This framework is based on the business drivers and goals for SFA. It factors in IT architecture best practices and industry trends. It is a living document and will be periodically reviewed and revised as often as SFA believes necessary in order to guide the design, development, and deployment of application and infrastructure systems and components.

For each principle of the architecture a note describes why adhering to this principle is important to SFA's future IT direction and how it relates to the strategy and business drivers of the organization (rationale). The implications on the organization for supporting that principle are then described in general terms. These principles have been organized into framework and component principles. The framework principles are the umbrella guidelines for all IT decision-making, while the component principles refer more specifically within the scope of: data, applications, technical infrastructure, and technology management.

Architecture Framework Principles:

1. **The Architecture Must Support the Business**: The enterprise architecture and standards will be designed to (1) support and optimize the SFA operations, (2) be highly flexible to accommodate future business changes and (3) help ensure the overall success of the SFA business.

   Rationale:

   Information technology can provide SFA with a set of tools and an enterprise information technology environment required to maintain a competitive advantage in today's business world. To positively impact the business, it is critical that SFA implement information technology that measurably improves the business and its processes. SFA must not implement technology simply because it is available.

   Implications:

- The information technology environment will be created / evolved through a top-down analysis process to ensure that the information infrastructure is aligned with the business strategy.
- IT investments will be directly linked to business needs, ensuring optimal investments and following SFA's benefit preferences -- investments will be customer focused and aligned with SFA's strategic goals.
- Information technology decisions made through this process may be sub-optimal for a specific project or program or for the short term (but optimal for SFA overall).

2. **Periodic Architecture Review, Alignment, & Refreshment**: The IT architecture will be periodically reviewed and updated according to a disciplined, structured maintenance and technology refreshment process. This structure will include a configuration management process and supporting tools.

   Rationale:

   Technology and business strategies both change rapidly. There must be a well defined process in place for these changes to be reflected in SFA's information architecture to ensure the continual alignment of both the organization and the technology. Reviews and revisions must be made as often as SFA believes necessary to guide the design and development of application and infrastructure systems and components. This allows the maximum opportunity for gains and leverage in the information environment. Dead-end technology is costly to operate and maintain.

   Implications:

   - Architecture refreshment will provide SFA with a current enterprise architecture to discipline information technology decisions.
   - If changes in the business or technology require changes in architecture principles and/or standards, these changes will also be made.
   - Technologies and standards will be retired when they are no longer useful to SFA or its future plans.
   - Refreshing the architecture will require skilled professional resources on a regular basis.
   - Maintenance of the architecture will require staff resources, a strong configuration management process and software tools.
   - Organizational entities with the responsibility for managing and updating the architecture must be identified.

3. **Reengineer Business Processes and Supporting IT Together**: New information systems will be implemented after work processes have been analyzed, simplified or otherwise redesigned as appropriate, in compliance with the Clinger-Cohen legislation and Raines' rules.

   Rationale:

   SFA must not simply apply new technology to old inefficient processes. The SFA business processes must be reengineered with the objective of ensuring that customer service is improved while costs are reduced, if possible. Additionally, this will help ensure that system components are developed /acquired which can be reused by other processes where ever possible.

   Implications:

   - Work processes will be more streamlined, efficient and cost effective in the long run.
   - Systems will not be developed "embalming" an antiquated work process and then later have to be re-developed.
   - Work process, activities, and associated business rules will be well understood and documented.
   - Software can be developed using tools which link business rules to software processes, increasing the efficiency of software development and long term maintainability.
   - Business processes will be highly responsive to business needs.
   - The Clinger-Cohen act and the Raines' rules will be complied with.
   - Additional time and resources will have to be invested in analysis early in the systems life cycle.
   - Change management and potentially painful organizational change will be required to implement reengineered work processes.
   - Greater benefits will be obtained in the long run from improving business processes but these benefits will be deferred due to the need for increased analysis up front and implementation of required organizational change.
   - A disciplined change management and systems development methodology will need to be followed to maximize SFA's potential for success in reengineering efforts.

4. **Architecture Enforcement:** The information systems and technology infrastructure implemented by SFA will be compliant with the SFA Enterprise Architecture and COE described within.

   Rationale:

In order for SFA to realize the benefits of a standards-based enterprise architecture and to comply with legislative and management directives, all information technology investments must be reviewed to ensure compliance with the established SFA IT architecture. SFA is required by OMB directive to establish a technical reference model and appropriate standards that are compliant with its enterprise architecture and to insure that all development/ acquisitions are consistent with the two.

Implications:

- Processes must be developed for all application procurement, development, design, and management incorporating the principles of this architecture.
- A structured investment management process consistent with the Clinger-Cohen legislation and OMB / GAO Capital Planning Requirements, must, as part of its process, ensure that SFA information systems comply with the SFA Enterprise Architecture and SFA standards.
- The architectural discipline will prevent SFA from implementing new technology until it is incorporated into the architecture and associated standards.

5. **Use Industry Proven Technology**: Information technology applications and technical infrastructure decisions must be based on industry proven and supported components, methods, standards, and tools consistent with industry technological and market direction and as defined by this architecture.

   Rationale:

   Information is a valuable group asset of SFA. It is important that the technology used to transport, access, view, modify, and share that information continues to maintain its integrity and accuracy. In addition, the need for SFA to exchange data with its partners, customers and other players in the education community requires that the SFA systems become standards based, increasing interoperability with the increasing numbers of systems operated by its customers and partners. While many new technologies may appear to have great benefit, adherence to this principle will create an environment that is more stable while minimizing risk and disruptions within the SFA infrastructure. The benefits of a managed and stable environment include increased information integrity; lower total cost of ownership; increased abilities to integrate components and applications; better data accessibility, system flexibility and management; better vendor support; and, lower internal support costs.

   Implications:

   - Products and technologies used by SFA will be proven, therefore minimizing technological and support risk.
   - The products and technologies that SFA selects for its infrastructure and application base must meet stringent requirements and be consistent and integrated with other SFA selected elements.

- Developing technologies (ie. "bleeding edge") which could potentially benefit SFA, will not be used.

6. **No vendor bias:** Standards and technology choices will be based on vendor-neutral standards where they are available and realistically can be implemented. Products will be chosen from any vendor with strong business stability, who provides the best technology and service for a business need.

   Rationale:

   It is important for SFA to create a strong and stable information infrastructure with longevity and open interconnection to other government systems, partners, and customers. Choosing vendor neutral standards where possible and de facto standards where necessary ensures SFA of maximizing interoperability with others.

   Implications:

   - SFA will minimize vendor dependence, having as many products as possible become commodity purchases.
   - SFA may forego integration opportunities available from a single vendor.
   - Standards must be carefully set to both follow long term industry trends and remain as vendor neutral as possible.

7. **Solutions Preference:** When all other factors are equal and where most cost effective and beneficial, SFA's solutions preference will be (1) reuse of existing applications; (2) commercial-off-the-shelf (COTS) products; (3) custom applications; and (4) outsourcing.

   Rationale:

   Given the development risk and maintenance cost, custom applications shall only be used when they offer a real competitive advantage. Use of proprietary/customized software is costly and inefficient when functional best practices are embodied in a COTS package or performed by another organization.

   Implications:

   - This acquisition strategy will appropriately allocate risk and effectively use competition consistent with the Raines' rules.
   - Where cost effective, COTS packages will be augmented with custom software as opposed to building an application from scratch.
   - Business processes will be reengineered to fit COTS or outsourced solutions – new applications are unlikely to precisely match existing business processes.

- Application maintenance and enhancement will tend to be done by commercial software vendors – SFA will have to accept vendor enhancements and maintenance schedules.
- SFA will have to commit to staying current with vendor software releases.
- When solutions are outsourced, SFA will have to develop and maintain interfaces between the outsourcer and the SFA integrated database.

8. **Access to Information**: Timely access to information and the tools and applications required to access and manipulate that information will be available to all individuals unless there is a specific, compelling reason to restrict access.

   Rationale:

   The access to information required to do one's job and the effective use of information technology is key to the competitive future of SFA. Users within the organization must be provided with the information and tools they need to perform operational and decision making tasks and communicate across the organization.

   Implications:

   - Appropriate security and confidentiality controls must be put in place to support information access processes.
   - Users will be able to perform their jobs more effectively and top management will have ready access to information for decision-making and reporting to stakeholders.
   - The technological infrastructure must be capable of implementing and supporting business-based access policy in a simple, timely and cost effective manner.
   - Business access policy, not technological capability or structure, should determine access rights.
   - Business access policy must be developed and maintained.

9. **Reduce Integration Complexity:** Products, tools, designs, applications, and methods will be selected to reduce integration and infrastructure complexity

   Rationale:

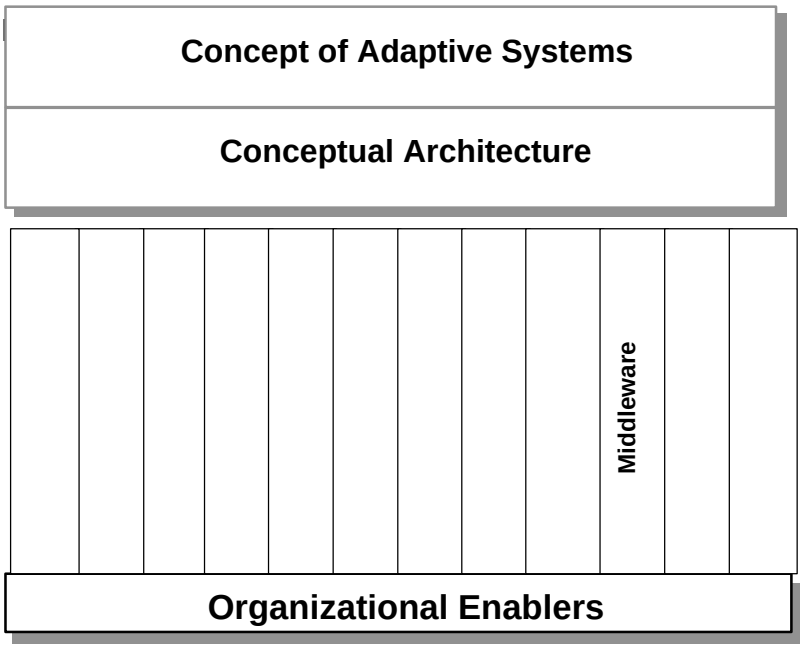
   The world of IT is becoming too complex. Products that have standard interfaces and adhere to open standards help reduce the complexity associated with the IT environment. This reduces the risk of operation and implementation of new systems and upgrades. Additionally, costs associated with help desk support, training and total cost of ownership can also be reduced through the reduction in the complexity of the information infrastructure. Less complex structures and better integration means easier information access and sharing that enable users to be more inclined to use the resources provided to them.

Implications:

- Risk of system implementation and upgrade will be reduced.
- SFA will have a more supportable information technology environment.
- To simplify integration of components, manage risk, and reduce the total cost of ownership, SFA must select components from a limited set of vendors and from those vendors that have broad product offerings and stability.
- SFA may have to forego leading edge technology which may provide benefits, if the complexity of the environment is increased beyond acceptable levels.

Architecture Component Principles:

Component principles are guidelines more focused on specific components/elements of the IT environment. Defined are 12 component categories within the information technology framework. These have been organized and mapped here into the broad categories of: data, applications, technical infrastructure, and technology management.



Data Architecture Principles:

The data architecture includes the component categories of:

Data Architecture: This addresses the information elements of significance to the enterprise and the relationship of the elements to each other. The structure and standards for accessing such information is defined by the Data Architecture.

Transaction Data Architecture: The Transaction Data Architecture describes those data elements relevant to operational activities and requests that must be recorded and accounted for in

a business information environment. It provides standards for accessing on-line transaction processing (OLTP) data.

Data Warehouse Architecture: Describes the internally consistent logical structure of authoritative databases and provides the standards for accessing decision support (EIS/DSS) and on-line analytical processing (OLAP) data. The data contained within these databases has typically been transformed, cleaned and audited to adhere to Information Architecture quality standards.

Object Architecture: Describes the business relevant entities, the sets of relationships between these entities, and the methods by which such entities are accessed. It defines how real world "things" – invoices, orders, products, etc. – interact and describes the behaviors that can be expected from each. Objects provide a common framework and terminology for the business users and technology organization to naturally describe the business and technology relationships.

10. **Data Stewardship:** Data is a SFA asset and does not belong to a particular business, program or individual. Individuals will be data stewards for particular periods of time but will not have overall ownership.

    Rationale:

    Data is a strategic asset that must be shared and easily accessed by all organization components if SFA is to gain maximum value from it. The business processes of SFA need unfettered access to all SFA data to best serve its customers and support management decision making.

    Implications:

    - SFA data must also be commonly defined across SFA to be useful to all.
    - All data will have a data steward responsible for managing its consistency, timeliness, security, accuracy and completeness.
    - All data structures and elements will be managed under a centralized configuration management control system.
    - A database of all applications referencing databases and their type of access will be maintained.

11. **Authoritative Source of Data:** Data will be captured only once at the source. All data will be stored in a single master "authoritative source".

Rationale:

Redundant, inconsistent, unsynchronized data renders any integrated database useless for broad business functions. A single authoritative source ensures that information will be useful for intended business functions. Additionally this greatly reduces integrated information system complexity, contains costs and boosts productivity.

Implications:

- Broad-based information about SFA's business, not available today, will be available for analysis and decision-making. This should greatly increase the business value of SFA's information technology investments.

- A single SFA data dictionary must be developed and maintained – this will be resource intensive.

- Duplicate and inconsistent copies of databases must be identified. Then through a migration process and set of initiatives, application references must be modified and formats adapted to use the single master copy. This is resource intensive and a tedious complex task.

12. **Manage data in its most appropriate form**: SFA's architecture and systems will address the storage and management of all forms of data (text, voice, video, etc.) needed to support the functional requirements of the business. The quality of SFA data shall be continuously improved over time.

    Rationale:

    SFA must afford its customers and partners access to data in many and varied forms so that they may choose the form that is most convenient for them at any time. Similarly SFA must be able to accept as input, process, and output data in many forms requiring the archiving of such varied forms. SFA data quality must be maintained at a high level.

    Implications:

    - The storage, processing, and presentation of information must be modularized so that information retrieved in one format may be transformed, processed, and output in appropriate formats.

    - Storage must be sized so that large multimedia files and objects can be stored.

    - Applications and standards must be multimedia capable to access and manipulate all forms of data stored.

    - The telecommunications infrastructure must be designed to transmit all forms of data adequately to meet performance requirements.

    - Investment in process and resources will be required to continuously improve data.

13. **Replication and Operational Data Storage:** Replicated/aggregated copies of data (datamarts) will be created where required for performance or other reasons. (For example, operational data used for transaction processing shall be separated from analysis or decision support data by creating data warehouses from the operational databases as required.) Replicated copies of data will be updated from the master source as often as required by the applications.

    Rationale:

    Replication of data supports principle 11 regarding having a single authoratative source of SFA data. Accessing operational data for decision support would adversely impact the performance and reliability of the transaction systems. Separation of this data ensures that SFA can develop optimal technical environments for transaction processing and decision support.. In addition, the structure of these databases may be very different, focused on different data elements and relationships. Finally, growth in OLTP is incremental -- OLTP database capacity can be reasonably well planned, while growth in data warehouse and end user computing can be non-linear and requirements are very difficult to predict.

    Implications:

    - Replication schemes will have to be carefully designed to minimize complexity while providing timely and accurate information.
    - A separate and distinct database design must be created and maintained for decision support information.
    - A separate group must be created and maintained to support the data warehouse.
    - Building and maintaining a data warehouse requires extensive business and technical expertise – it is resource intensive.
    - Significant business benefits will be obtained by analysis of the data warehouse information.
    - Development of a separate data warehouse will increase capital costs in the short run.
    - A separate data warehouse ensures that experimentation in the data warehouse will not impact transaction processing.

14. **Database Design:** All databases will use the standard SFA entity relationship tool for database design and documentation of the data structures. The data models will be kept in a central repository and databases will share common data models and data definitions. A

metadata dictionary (repository warehouse) defining fields and attributes will be maintained in a shared accessible area and used as the basis for the creation of data structures.

Rationale:

The key to the future sharing of information is the consistent definition of fields and relationships among data elements. Common data models, shared in a common repository will facilitate this consistency.

Implications:

- Data will evolve to being standardized across SFA and will be under configuration control.
- Standard data will facilitate SFA's ability to perform additional business functions, and reduce the long term cost of systems development and implementation.
- A data standards group must be created in SFA to perform and support data standardization efforts and the use of common tools. This will require technical expertise and resources.
- The data standards group must select a standard tool, enforce its use across projects, set up a shared metadata repository, and set a development process that will ensure the creation of shared common models.

15. **Business Logic:** Where appropriate and cost effective, business logic will be separate from data access logic in SFA's future information systems.

Rationale:

The key to the future of flexible distributed systems is the partitioning of its elements across logical boundaries. The clean separation of data, business logic, and presentation services will result in a flexible logical structure that can be mapped to a variety of physical models as requirements dictate. This also supports data independence, scalability, and flexibility in the data environment.

Implications:

- SFA's systems will be more flexible and scalable to more cost effectively meet changing business requirements.
- The design and development process will need to include appropriate architecture reviews to ensure the clean separation of computing elements. Overall, more structure and discipline will be required in SFA's systems development processes.

Application Architecture Principles:

The application architecture includes the component categories of:

Application Architecture: Application Architecture is the focal point of an organization's systems. It defines how applications are designed & structured, how they cooperate & communicate, and where they reside. Good application architectures will enable a high level of distributed system integration, reuse of components, rapid deployment of applications, and high responsiveness to changing business requirements.

Internet/Intranet Architecture: Internet/Intranet Architecture exploits the technologies of the Web to create seamless, platform independent universal access mechanisms. These technologies reduce the cost and complexity of information access, especially to the external world. This technology supports universal access across communication, information system, and application structures. The architecture addresses issues of security, development tools, search engines, groupware, and database connectivity.

16. **Structure of Business Applications**: Application design shall be based on partitioned *logical* model (presentation, application logic, database) with firm logical boundaries established between the partitions.

Rationale:

Achieving flexibility in the design of distributed applications requires the logical partitioning of these distinct functions. This increases the application stability over time. This structure enables application extensibility and scalability and the sharing of information across applications. Physical partitioning evolves as technology evolves and applications scale. The logical model does not necessarily imply multiple servers. The logical to physical mapping is dependent on the technology chosen and performance parameters.

Implications:

- SFA systems will be developed using standard components in a way that maximizes flexibility and recognizes the need to accommodate future changes to functional and technology requirements.
- The design and development costs may be higher initially but the benefits will be significant in the long term.
- Development of applications in this manner requires expertise and software engineering discipline.

17. **Reuse and Components**: Opportunities will be identified for cross-functional, integrated systems and these systems will be implemented to take advantage of standard components that can be shared and reused throughout SFA for similar business functions.

Rationale:

The creation and reuse of standard elements will result in high efficiency development and lower costs of support, training, and testing.

Implications:

- The long term costs of systems development and maintenance should be reduced.
- Components will need to be maintained through a version management control system, which includes a repository of metadata for reusable components. A standard such as Uniform Modeling Language (UML) may need to be implemented to support this.
- Developers should be given incentives to create reusable library components.
- Implementation of this principle will require a high degree of communication and integration across SFA's information systems.
- Applications will need to be centrally managed to implement this principle.

18. **Modular implementation for upgrade**: Technology components will be implemented in as modular a fashion as possible to allow the upgrade and exchange of vendor products with minimal disruption to the overall environment.

    Rationale:

    Modular implementation will reduce the cost, complexity and elapsed time for upgrades while providing SFA with improved functionality.

    Implications:

    - Modular implementation will require additional effort at the front end of the implementation project.
    - Expertise and disciplined software process must be put in place for these benefits to be realized.
    - Vendor expertise and cooperation will be required to implement this principle.

19. **Presentation Consistency:** All presentation user interfaces will adhere to SFA's standard graphical user interface to have a consistent look and feel. Presentation layer interfaces will be consistent across local and remote access. The preferred presentation interface will be based on Web browser technology capabilities.

    Rationale:

    A major cost in the deployment of new applications is user training. Common user interfaces will: reduce that training effort, allow reuse of presentation service components, and result in fewer operational errors due to commonality of the interface look and feel. In addition, use of

Web technology will support access by both internal and external users across this universal presentation medium.

Implications:

- Applications will present a common user interface that is adaptable and extendible to a wide variety of user environments.
- SFA must set standards in this area.
- SFA will need to require that all users on its systems be trained and knowledgeable of the standard interface.

20. **Object-oriented Design and Structure:** Where practical, applications shall be designed using objects, which encapsulate data structures and present a functional interface to application logic.

Rationale:

Objects create a functional interface to data elements and leave developers free to modify the access methods and underlying data structures, independent of the application. Business objects support reuse across many varied applications. Object designs add to the flexibility of the information environment.

Implications:

- Designers and developers must be trained in this design methodology.
- This methodology requires a high level of software engineering discipline and expertise.
- Guidelines for design and development will need to be created and enforced within SFA.

21. **Event Driven Processing:** Where practical, application design shall be event driven, employing a real-time processing methodology versus batch processing.

Rationale:

Real-time event processing allows rapid response to business events and proper time sequencing of event actions. It helps create a more current and consistent data environment. It also supports the concept of 7 x 24 operation and a fully accessible data infrastructure. In addition, as databases continue to grow, the “batch cycle” can grow to exceed the available time window. Real-time business event processing solves this problem.

Implications:

- SFA will benefit significantly from more current and consistent information availability.

- Designers and developers must understand this structure of application design and development.

- Guidelines for design and development will need to be created and enforced within the SFA systems development environment.

- Applications will tend to be more complex.

22. **Use of Automated Development and Testing Tools:** Standardized information systems tools will be used across SFA for business modeling, systems design, development, and configuration management. Application development and testing will maximize their reliance on automated tools.

Rationale:

Applications and systems are very complex. Developing applications can be greatly speeded and be made more maintainable by using automated tools for development. Testing contemporary applications requires navigating the user interface through its many alternate paths, variable values, button click choices, etc. It is not possible for humans to stress test such applications. Configuration management is critical to SFA IT management. These tools will be used in conjunction with a standard software development / engineering methodology.

Implications:

- The organization must select an appropriate testing tool, train developers and support the tool, test it on pilot projects and then set guidelines for its use.

- Software quality should be increased through the use of tools.

- Effective use of tools requires a disciplined software engineering approach and development methodology.

- Integrated configuration management will require a new level of discipline for SFA and will likely slow down the pace at which changes are currently being made.

Technical Infrastructure Architecture Principles:

The technical infrastructure architecture includes the component categories of:

Network Architecture: The Network Architecture provides the communication infrastructure for the distributed computing environment. It consists of logical elements: structure, topology, bandwidth, management; physical hardware components: wiring, LANs, hubs; carrier services: frame relay, leased channels, ATM; and protocols: access, routing, naming. It may incorporate telecommunication services if they are integrated within the enterprise organizational structure.

Platform Architecture: The Platform Architecture defines the technical components of the structure, including: the client and server hardware platforms, the operating systems executing on those platforms, and the database environments and interfaces supported. The choices here should be driven by the overall business needs, especially choices of vendor relationships and support.

Middleware Architecture: Middleware Architectures create a solution to and encompass those components that create an integration environment between the user workstations (clients) and the legacy and server environments to improve the overall usability of the distributed infrastructure to the user. Middleware solutions sit between the applications and the network communication mechanisms. They create uniform mechanisms for application integration independent of network and platform technologies.

Workflow Architecture: Workflow Architecture describes the rules and practices of activity-focused (as opposed to conversation-focused) business behavior. It distills the essence of the bureaucratic functions within an enterprise, "translating" human behavior into data processing events.

Collaborative Architecture: Collaborative Architecture describes the rules and behaviors of conversation-focused (as opposed to activity-focused) business behavior. It is focused upon the analysis of workflow and concentrates on supporting what we "say" about the enterprise, not on what we "do" within it.

Security Architecture: Security architecture describes the behavior, rules, and requirements of the information systems regarding appropriate access to IT resources, including data. It is focused on maintaining the security and privacy of IT resources.

23. **Common Security Access:** The infrastructure will present a consistent, uniform, and adequate security mechanism across all applications, data access, and related components independent of physical location. Technologies such as a single logon with a database for profile definition and token-based authentication will be incorporated when applicable.

    Rationale:

    A consistent security mechanism will be most effective in providing integrated access to authorized portions of SFA's information systems. A single logon is easiest to administer and change to provide timely access to needed information across SFA's business. To assist users in upholding security policy, SFA security mechanisms will be easy to use and maintain while providing the needed protection.

    Implications:

    - Security must be designed into the architecture of SFA's systems "from the ground up".
    - Given that security is designed in, security design requirements for individual applications should be reduced overall.
    - Management will be able to change user privileges and access quickly.

- Security requirements will be based on business requirements, not technical requirements.

24. **Network Design:** All network components will adhere to the SFA network standards for protocols, addressing, and firewall security. Any SFA desktop will be logically able to access any application and database within the SFA computing environment, within security and operational considerations

    Rationale:

    Networks are the backbone of distributed computing. Their standardization, flexibility, and capability really determine how adaptable the computing infrastructure will be to future changing requirements. Investment in a flexible network infrastructure is critical so that the IT architecture will be able to support the required technology and applications.

    Implications:

    - The network design must be designed to be flexible to allow for future geographic expansion and bandwidth requirements.
    - This may require increased investment up-front, but will yield substantial benefits in the future.
    - Network standards must be clearly defined and periodically refreshed.
    - SFA's network standards must meet SFA requirements, yet interface with the Department's network for common services such as messaging.

25. **Electronic Commerce:** Standards-based electronic links will be the preferred means of transacting business and communicating with partners and customers as required.

    Rationale:

    The electronic sharing of information eliminates extra effort and errors due to reentry. It also supports the rapid dissemination and sharing of information. This is consistent with SFA's goal of improving customer service at potentially reduced cost.

    Implications:

    - Internet technology is likely to be key to implementing this principle. SFA will need to employ significant expertise in electronic commerce and internet technologies.
    - SFA may forego some opportunities for electronic commerce in the short term if they are not standards-based or easily translatable through protocol conversion.
    - SFA must, as part of its repeatable design process, evaluate and pursue opportunities for electronic interchange whenever the processes of collection, storage, or dissemination of information can be improved.

- Data elements with SFA's integrated database must either be consistent with electronic link standards where applicable or translatable into standard formats.

IT Management Architecture Principles:

The IT management architecture includes the component categories of:

Integration Architecture: The Integration Architecture defines how the components of the distributed computing environment interact both vertically and horizontally in the infrastructure. It is focused on issues of security, performance, flexibility, availability, and maintainability of the distributed environment. It addresses the critical issues of the integration and access of legacy systems and environments with contemporary distributed components.

Systems Management Architecture: The Systems Management Architecture defines how the hardware and software components of the environment will be controlled. It focuses on issues of configuration management, fault detection and isolation, testing, performance measurement, problem reporting, and software upgrades and control.

26. **Common IT infrastructure**: SFA will implement a common IT infrastructure for its systems. Applications will operate on this infrastructure.

    Rationale:

    A common infrastructure will maximize SFA's ability to efficiently perform current business functions. Additionally, this will maximize SFA's flexibility to respond to business changes in a timely and cost effective manner. Additionally, this will promote interoperability between loan programs, reduce redundancy, and exploit economies of scale.

    Implications:

    - Implementing this principle will require business and information technology management discipline.
    - SFA will accrue long term benefits from increased interoperability, reduced redundancy, and economies of scale.
    - SFA may need to forego IT solutions which could provide benefits, if these solutions cannot operate on the infrastructure.

27. **Migration Planning:** Movement toward the target architecture implementation and replacement efforts will be planned and implemented in functional or technical infrastructure sub-elements (e.g., chunks, releases, plateaus) to minimize SFA risk.

    Rationale:

    Changes in the infrastructure and replacement of business systems is complex, costly, and not without significant risk. Migrating by chunks and implementing new business capability in

releases, will allow the organization to assess each initiative, plan accordingly, and minimize overall risk to the organization and its stable infrastructure.

Implications:

- SFA must define transition schedules and sunset dates for legacy systems that do not comply with the SFA architecture. This must be done in a manner which ensures an uninterrupted, continual high level of service to SFA users and customers.
- Each release of business capability must provide significant business benefit to SFA. Business value must be a key focus and driver for each release and be thoroughly communicated to all involved parties.
- Implementation of this principle implies the need to develop and maintain temporary application bridges while each release is put into place. This adds short term complexity.
- This approach should minimize SFA's risk and long term cost of moving toward its target architecture.

28. **Security Policy**: Security policies and practices will be consistently implemented to ensure the confidentiality, integrity, and availability of SFA data and systems. Policy monitoring and coordination of system-wide security measures and contingency plans will be the responsibility of SFAP management.

    Rationale:

    Security and privacy of SFA systems and data is paramount. Security is everyone's responsibility, and as such, top management must develop and implement system-wide security measures. This will provide guidance and facilitate the security and privacy of all systems.

    Implications:

    - SFA top executive and IT management will need to be proactive in developing and maintaining security and related policies.
    - System specific security policies must fall within the overall SFA guidelines unless specifically exempted due to unusual business requirements.
    - SFA will need to create and maintain a working group to develop and support system-wide security guidelines and policies.
    - System-wide security policy may be contentious and require significant elapsed time to gain consensus.

29. **IT Project Evaluation and Review:** A structured IT investment process consistent with the Clinger-Cohen legislation and OMB / GAO capital planning requirements will be used by SFA

to manage its IT investments. This process should be implemented in a pragmatic way without sacrificing the key discipline elements.

Rationale:

It is critical that SFA select IT / business solutions that are the best investments for the organization in the long term. Additionally, it is critical that SFA prioritize its investments to ensure that scarce resources are expended in a manner that maximizes business value.

Implications:

- IT projects will need to be evaluated and alternatives assessed using a full life cycle, risk adjusted cost benefit analysis. SFA will need to create and maintain an analysis group for this task.
- As part of the investment process, IT projects will be monitored by an architecture group for architectural compliance during project evaluation, product selection, design, development, and deployment.
- SFA IT resources will be expended in an efficient manner and business value for SFA will be maximized.
- IT projects will need to meet the requirements of the investment process to proceed. This will create some additional short-term work, and also may cause minor time delays.
- Decisions must be made to optimize for the enterprise, even if that results in a suboptimal solution within a particular group.

30. **Security Conformance:** All users of IT will conform to group and corporate security policies, protecting the integrity, reliability, and privacy of all SFA information assets. (Integrity includes adherence to purchased product licensing policies.)

Rationale:

Information is an extremely valuable asset of SFA. Security and privacy of SFA systems and data is paramount. Conformance with SFA policies will safeguard information assets.

Implications:

- Compliance may reduce user flexibility to a degree.
- Compliance will maximize SFA's protection of IT assets.
- SFA should develop budgetary flexibility to purchase low cost licensed products in a timely manner, to minimize user temptation to use products without authorized licenses.

31. **Systems Development Methodology:** SFA will adopt and utilize a standard methodology for the implementation of IT solutions. The methodology will, at a minimum, address systems development--design, development, and testing of IT solutions.

    Rationale:

    Use of a standard development methodology will help to implement best practices, provide a basis for SFA contract management and visibility into contractor's processes, and support disciplined software development processes. This will decrease SFA risk and increase long term systems flexibility and business value delivered.

    Implications:

    - A working group will be required to facilitate implementation of the methodology and to communicate enhancements to the methodology. Initially, this will be resource intensive and will be a cultural change for SFA.
    - By staying with the discipline of a methodology, SFA's IT development will not be able to short-circuit standard tasks and deliverables, even if this may seem beneficial in the short run.

32. **Acquisition Methodology:** Software implementing the target architecture will be acquired by SFA using a structured process consistent with the Software Engineering Institute's Software Acquisition Capability Maturity Model to mitigate risk. SFA will work to continuously improve this process over time.

    Rationale:

    It is critical that SFA bring consistency and repeatability to its software acquisition process and that SFA aggressively manage this process and its contractors. This will reduce the risk and cost of software acquisition in the long run. The Software Engineering Institute's Software Acquisition Capability Maturity Model is recognized as defining an appropriate process and methodology for software acquisition.

    Implications:

    - SFA must commit to attaining level 2 of the Software Engineering Institute's Software Acquisition Capability Maturity Model in the short term. In the long term, level 3 and above should be targets.
    - A companion software development methodology must be implemented to enable SFA to manage and improve its systems life cycle.
    - Moving to level 2 can be evolutionary but will require a resource and expertise commitment by SFA.
    - SFA's software acquisition risk and costs should be reduced in the long term.

33. **Project Tracking:** IT projects will use the standard SFA project management methodology and tool to track projects.

Rationale:

Active management of IT projects is critical to their success – IT projects are by their very nature, high risk. Generically, a high percentage of IT projects have cost overruns and are poorly managed. Use of a project management methodology and standard tool should contribute to reducing this risk.

Implications:

- A standardized project management methodology and tool must be selected.
- SFA and its systems integrator must have expertise in the methodology and project management tool. This will require knowledgeable SFA resources.
- A standard methodology and tool will minimize training costs and facilitate SFA project communications and management.

34. **Metrics Tracking:** Applications and technical infrastructure will be implemented in a way that facilitates the capture of measurement data and metrics for analysis and for management of the information technology and business environments.

Rationale:

The only way to ensure that management and development policies, procedures, and processes are working effectively is to measure that effectiveness. Measurement is done by collecting the relevant data as metrics and then computing the appropriate measures.

Implications:

- Implementation of this principle will require that measurements and metrics be defined during the design phase so that IT systems can capture the metrics as a by-product of normal processing.
- The business must be proactive in developing clearly defined performance measures.
- SFA will have timely and complete measures of its performance and associated IT performance.

Appendices

Appendix A: U.S. Department of Education's Customer Service Standards

(Issued June 1996)

If you contact us with an inquiry about the Department of Education or ask for other information:

- We will answer your written inquiry within 15 working days.
- If you telephone us, you will speak to a knowledgeable person who will answer your question or refer it properly. You will receive no more than two referrals.
- We will answer phone calls promptly, within three rings, and return all voice-mail messages
- within 48 hours.
- We will respond to your e-mail messages within 48 hours.
- If you have a personal appointment with a Department employee, you will not be kept waiting.

If you request one of our publications or documents:

- Requests for single copies of publications by telephone will be sent within 48 hours.
- Request for single copies by mail and all bulk orders will be filled within 72 hours.
- Publications and documents will be made available in alternative formats on request.
- We will give you the option to receive information in electronic form where possible.

If you contact us about a complaint:

- We will respond to written complaints within 15 working days.
- If you telephone us with a complaint, we will advise you on the telephone or refer your complaint to the proper source.

If you are a prospective grant applicant or existing grantee, or if you are a prospective or current recipient of student financial assistance:

- We will disseminate timely and accurate information on grant opportunities and provide clear guidelines for grant proposals and criteria for selection.
- We will disseminate timely and accurate information on student financial aid application procedures and program provisions.
- We will acknowledge receipt of requests for administrative actions and other inquiries within 48 hours.
- Final response on administrative actions will be completed in 30 calendar days.
- Grant award documents will clearly identify which requests should be referred to the grant specialist or program specialist and which grantee actions do not require approval.

- We will provide timely, accurate, and dependable technical assistance.
- We will provide information that explains the final funding decision.
- We will institute sensible reporting requirements and, when conducting monitoring and site visits, perform exit interviews and make final monitoring reports available within 30 days.

Appendix B: Industry Best Practices

There are a consistent group of 'Best Practices that have been used by a wide range of organizations that have achieved Adaptive Systems across the enterprise. In this section we have drawn from hands-on engagements to identify a set of Recommended Best Practices. The Recommended Practices span all of the component architectures.

Unified Architecture Management

The planning and management of an enterprise's technical architecture must be unified.

- There should be an architecture function, reporting to the CIO.
- Unified architecture management facilitates standards development and enforcement.

Reduce Integration Complexity

A goal of the enterprise architecture must be to reduce integration complexity to the extent possible.

- Reduced integration complexity increases the capacity of the infrastructure to 'adapt'.
- It lowers the cost of support and the Total Cost of Ownership.

Application Partitioning

The logical design of application systems should be highly partitioned into discrete service layers.

- This supports the reuse of components.
- It also supports scaling by allowing physical partitioning of functions across servers.

Database Partitioning

Databases should have a high degree of logical partitioning.

- This supports the scaling of databases across physical servers and high performance through parallel access across servers.

Firm Logical Boundaries

Logical boundaries must be established between the partitions, application or database, and the logical boundaries must be *inviolate*.

- This supports flexibility and scaling (up and down) of applications and data across or within servers.

Message-Based Interfaces

The interfaces between separate application systems must be *message-based*.

- This supports the integration of heterogeneous servers and SFArating system platforms.
- It also supports the concept of autonomous asynchronous execution.
- These interfaces must extend across the value chain to include both customers and suppliers.

Event-Driven Systems

We must deploy application systems that are (business) *event-driven*.

- This allows rapid response to business events and prSFAr time sequencing of event actions.

Highly Granular, Loosely Coupled

We must re-engineer our application systems to be *'highly granular'* and *'loosely coupled'*.

- Highly granular, loosely coupled components are requirements for partitioned, reusable application components.

Server Partitioning-"Workloads"

Applications and databases should be *physically partitioned* on separate servers, in the same location, based on workload.

- Applications with differing characteristics can adversely affect each other's performance.

Separate OLTP from Data Warehouse

We should separate on line transaction processing (OLTP) from Data Warehouse and other end user computing.

- Growth in OLTP is incremental and requirements are predictable. Growth in D/W and end user computing has been non-linear and requirements are very difficult to predict.

Client/Server Model

Application systems must be implemented using the *client/server model*.

- This separates user presentation services from applications and information storage. It is a flexible distributed computing model.

- It supports flexible physical partitioning of applications and data, scalability, and sharing of information.

Enterprise Network as Virtual LAN

We must implement an enterprise-wide, backbone network that provides a 'single network image' as if it were a virtual, enterprise-wide LAN.

- A single network image is the foundation for enterprise-wide network-centric computing.
- Without investment in a flexible network infrastructure, the IT architecture will not be able to support the rest of the technology and applications needed.

Appropriate Geographic Partitioning

Applications and databases should be *geographically partitioned* as appropriate.

- This reduces network bandwidth requirements and results in more responsive applications.

Virtual Data Center

Geographic partitioning should be delivered using the concept of a *virtual data center*.

- Manage multiple servers as multiple instances of a single image.
- Invest in h/w and s/w rather than support staff and tuning.

Leverage Data Warehouse

We should leverage the Data Warehouse to *accelerate* decision-making and reduce the development burden.

- Emphasis on multiple Data Warehouses and using replicated data.

Evolve To "Push Model"

We should evolve to a PUSH model for information delivery where appropriate.

- This reduces computing and network overhead.

"Build" For Competitive Advantage

We should 'Build' those applications which will provide competitive advantage.

- We should 'Buy' those applications which will provide competitive parity.

Redefine The Programmer Domain

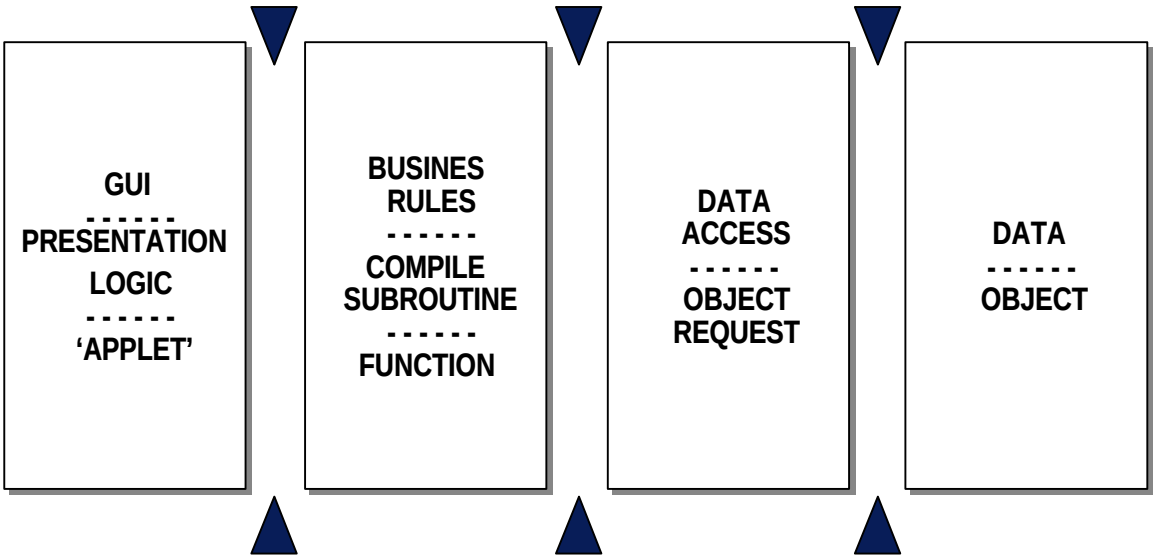
In order to achieve *Enterprise-RAD* we must redefine the *domain of the programmer*.

- Often the most difficult 'Best Practice' to implement.
- The programmer must become the assembler of parts in the software factory.

Component-Based "N-Tier" Model

Application Systems should employ reusable components using an N-tier model where appropriate.

- Enforce Logical Boundaries Between Tiers:



- Logical partitioning deals with design principles and physical partitioning deals with technology.
- Logical partitioning tends to be more stable over time.
- Physical partitioning evolves as technology evolves and applications scale.
- This enables the application to be extensible and scaleable.
- Logical boundaries do not necessarily coincide with physical boundaries.

Object-Oriented

Application delivery should be evolving toward an object-oriented approach.

- Business objects support reuse across applications.

Share Components

Application systems should *share* reusable components across the enterprise.

Comprehensive "Work" Architecture

Evolve a comprehensive 'information architecture' which encompasses the entire 'work architecture' -- process models, 'events', transaction data, state descriptions, and so forth.

- This creates a consistent information environment.

Appendix C: Technology Trends

This section addresses current global market and technology trends for the next 2 to 5 years as the computer industry itself sees them. It is not a SFA specific view. The list of trends also is not an exhaustive one, rather it's a scaled down short list that impacts SFA in some way. Trends themselves do not judge the quality of a technology, as we all know the best technology doesn't always survive in the end. Additionally, this list is not an indication that SFA endorses or will follow all of the identified trends. They do influence our architecture requirements and conceptual principles.

Trend #1:	TCP/IP is the dominant network protocol and is a fundamental component of today's network infrastructure and will continue its dominance.
Trend #2:	Moore's law will hold for the next 10 years (i.e. cpu will double performance and capacity every 18 months at the same price point).
Trend #3:	Mass storage and memory prices will continue to drop.
Trend #4:	Available network bandwidth will increase faster than Moore's law.
Trend #5:	The Internet and web browser technologies are becoming more pervasive and are rapidly becoming a core technology for easy user access to information and data.
Trend #6:	E-commerce will become more common for business transactions.
Trend #7:	The number of Internet connected consumers will continue to grow.
Trend #8:	Microsoft will continue to dominate the desktop OS for the foreseeable future.
Trend #9:	Windows NT server will become more scaleable, displacing UNIX as the primary server SFArating system for new production applications (mission critical).
Trend #10:	Relational database management systems will incorporate object-oriented technology.
Trend #11:	The virtual data center will be the dominant way of supporting the accelerating rates of change in the business process.
Trend #12:	Enterprise architectures will be dominated by n-tier distributed and collaborative components.

Trend #13:	The use of workflow and electronic document handling will increase dramatically over the next 3 years.
Trend #14:	Mainframes will continue to serve core enterprise applications.
Trend #15:	Messaging based communication will replace remote procedure calls as the dominant inter-process communication method.
Trend #16:	Data warehouses and data mining will become widely used.
Trend #17:	Applications development will change from a “craftsman” approach to a culture of assembly and re-use.
Trend #18:	ActiveX versus Java Beans, and DCOM verses CORBA wars will not be resolved in the next 2 to 3 years.
Trend #19:	Applications development will become more pervasive on Windows NT over the next 2 to 3 years.
Trend #20:	Intel is the dominant computer processor technology and this dominance will continue and even expand.
Trend #21:	Wireless LAN usage will increase.
Trend #22:	Enterprise-wide network and systems management will become standards based allowing multi-vendor solutions.
Trend #23:	Personal Digital Assistants will become more prevalent.
Trend #24:	The Internet will drive the standards for network computing and e-commerce.

Appendix D: Architecture Process & Document Section Information

SFA has chosen to follow the DOD's TAFIM methodology to develop its standards-based enterprise architecture. Selected definitions and deliverables from the enterprise architecture effort are listed below:

- **Business Drivers**
    - External factors driving the business to change. The organization's reaction to these drivers, in the form of goals, forms the foundation that links the business with the IT architecture. The goals define the criteria the architecture must meet for success. They must be specific, measurable, and attainable.
- **Vision/Target IT Architecture**
    - Example scenarios of business processes and operations with the required IT enabling and support functions operationally described. Principles related to organization structure, support, and business processes are described. The vision is the end product of the IT strategy and architecture efforts coupled with industry best practices and constraints imposed by the existing environment. A high level scenario is included in this document. A more detailed vision and target architecture will be included in the target architecture deliverable. This target architecture will be defined using multiple views which will be consistent with the views describing the current baseline.
- **Conceptual Architecture**
    - The architectural requirements and resulting principles that support the business information requirements of the organization. The principles are derived from the information requirements and industry best practices and technology trends. They are statements of direction and practice focused on the strategic use and management of information and related technology. It promotes organizational consensus and a shared understanding of IT across the enterprise. Each principle includes a definition statement, rationale why important, and implication for the organization.
- **Component Architectures**
    - Coupled with the conceptual principles, these are the principles, guidelines, frameworks, standards, and product lists that, when followed, will meet the IT requirements and support the strategic direction of the business. A cohesive framework that satisfies the IT requirements, vision, and business drivers of the enterprise. The selection of components and the depth of detail in each is specific to each organization and its requirements, but are usually divided into the broad categories of data, applications, infrastructure, and management. The architecture and the vision promote organizational consensus and a shared understanding of IT across the enterprise.

- **"As-Is" or Baseline Architecture & Environment**
    - A high level view of the current architecture and IT environment that can be compared with the proposed Vision Environment and Architecture. It explains where the current environment and structure are failing to meet the demands of the business and support its strategic direction. The current architecture inventory points to specific instances with the potential for information and application sharing and reuse. Current standards and IT skill capabilities are also described. The current baseline will be described using multiple views.
- **Gap Identification & Analysis**
    - The IT components that must be modified, replaced, and/or added to the existing environment to realize the desired architecture state.
- **Migration Plan**
    - The business priorities, constraints, budgets, and timeframe for realizing the desired infrastructure, data, and application environment. Metrics for each effort and for success of the architecture are defined. Sourcing alternatives are explored. It is the architecture and migration plan that provide the roadmap and filter during initiative execution to guide and constrain the design, development, and deployment of technology components and business applications.
- **Organization Structure**
    - The organization structure required to successfully execute this plan and support the vision/target environment is described. A plan to migrate to such an organization, timeframe, potential issues, and management requirements are outlined. . Metrics for organizational success are defined.
- **Architecture Management**
    - The organization structure, committees, and processes necessary to create this architecture and manage its development and realignment and refreshment over time with changes in the business. It describes how the architecture is used and enforced in the selection, design, development, and deployment of information technology components.

Appendix E: Architectural Inventory – "As-Is" Environment for Current System Baseline

The next step in enterprise architecture development is to document the "as-is" environment in a baseline characterization document. This then becomes input to the gap analysis step. The key step in this process is to create a high level system inventory for characterizing the SFA baseline architecture. This inventory process will document those features of existing data and application components that are critical to adaptive architecture success:

- eliminating duplicate and inconsistent databases,
- eliminating functionally duplicate applications,
- eliminating obsolete and unused technology components,
- enhancing and support database sharing,
- supporting shared applications and components and reuse, and
- creating an environment with increased maneuverability: scalability, portability, maintainability, flexibility.

Where many system inventory efforts document details on data elements and application structures, this effort focuses on the architecture and will document the linkage of databases and applications to business processes, their usage within SFA, their relationship to each other, and their adherence to SFA architecture principles.

Business Processes:

For each major business process we will document at a high level:

- What it does (process function description)
- Who is responsible for the process
- Who executes the process
- What data does it access and update
- What data is shared with other processes
- What applications access the data
- What interactions occur with other processes

A template for these business processes includes the following:

Name_____

Purpose/Description_____

Responsible individual_____

Who executes_____Location_____

Databases accessed_____

Data shared_____Process_____

Applications used_____

Interactions processes_____

Databases:

For each database referenced in a business process we will document its basic characteristics and conformance relative to our architecture goals and principles. A template for each database includes:

Name_____

Description of information_____

Location_____

Platform (hardware, software, db engine)_____

Access interfaces_____

Accessed by processes/LOBs_____

How populated (source)_____

How updated_____

Security controls_____

Approx. size_____

Who responsible_____

Database accuracy, completeness, timeliness_____

Usage (operational, analysis)_____

Database maintenance (tools, metadata repository)_____

Use of stored/embedded procedures_____

Applications:

For each application referenced in a business process we will document its basic characteristics and conformance relative to our architecture goals and principles. A template for each application includes:

Name_____

Vendor (bought, built, tools)_____

Description of application_____

Location_____

Platform (hardware, software, db engine)_____

Who responsible_____

Accessed by processes/LOBs_____

Security controls_____

Effectiveness in supporting the business process_____

Structure (tiers, logic, message interface)_____

Interfaces (database, other apps)_____

User interface (3270, PC, Web)_____

Database(s) accessed (which, method)_____

Status (active, in development, obsolete)_____

Y2K compliance (status of effort)_____